

U.S. Patent Application Serial No. 09/884,998
Amendment dated December 31, 2003
Reply to OA of October 2, 2003

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1 - 24 (Canceled)

Claim 25 (Previously Presented): A crawler belt bushing, comprising quench hardened layers formed so as to extend toward its wall core from its outer circumferential surface and from its inner circumferential surface respectively, and a soft layer formed between said quench hardened layers,

said quench hardened layers and said soft layer being formed such that the quench hardened layer of the outer circumferential surface has a depth greater than the depth of the quench hardened layer of the inner circumferential surface, by: (a) increasing the cooling rate of the outer circumferential surface in order to reduce heat capacity at the core and by second cooling of the workpiece from its outer circumferential surface which is started a certain time after the first cooling and/or (b) increasing the cooling rate of the outer circumferential surface by first cooling of the workpiece from its inner circumferential surface in order to partially make the core unhardenable by utilizing the mass effect of the wall of the workpiece and by second cooling of the workpiece from its outer circumferential surface which is started a certain time after the first cooling,

said soft layer having a core region and intermediate regions, one of said intermediate regions

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being between said core region and a respective one of said quench hardened layers, said core region being composed of one or more structures selected from the group consisting of ferrite, pearlite, bainite and martensite which are precipitated during cooling from the quenching temperature, said bushing being low temperature tempered.

Claim 26 (Original): A crawler belt bushing according to claim 25, wherein the hardened depth of the outer circumferential surface is not less than 1.1 times the hardened depth of the inner circumferential surface.

Claim 27 (Original): A crawler belt bushing according to claim 25 or 26, which is made of a steel having a carbon content equal to those of medium carbon steels and/or eutectoid steels, which is 0.35 wt% or more and having an alloy content within the range of DI values with which the bushing is through hardened by simultaneous cooling of the inner and outer circumferential surfaces and with which the hardened depth obtained by cooling from the inner circumferential surface only is about one half the thickness of the bushing.

Claim 28 (Currently Amended): A crawler belt bushing according to claim 25, which is tempered at high temperature such that the quench hardened layer of the inner circumferential surface has ~~[[higher]]~~ lower hardness than the quench hardened layer of the outer circumferential surface and wherein the surface hardness of the quench hardened layer of the inner circumferential surface is adjusted to Vickers hardness Hv 450 to 650.

Claim 29 (Original): A crawler belt bushing according to claim 25, which is through hardened at its upper and lower ends.

Claim 30 (Currently Amended): A crawler belt bushing having a carbon 0.35 to 2.0 wt%, containing at least one of the alloying elements of Mn, Si, Cr, Mo and Ni, and made by a method in which

a bushing workpiece made of steel, which is through hardened by simultaneous cooling from the outer and inner circumferential surfaces of the workpiece, ~~is induction heated from the outer circumferential surfaces of the workpiece,~~ is induction heated from the outer circumferential surface so as to raise at least the surface temperature of the inner circumferential surface to a quenching temperature, and thereafter, a series of quenching operations comprising:

firstly cooling the workpiece from the inner circumferential surface;

1. heating the workpiece from the outer circumferential surface while cooling the workpiece from the inner circumferential surface; and

2. then, cooling the workpiece from the outer circumferential surface,

so as to form quench hardened layers which extend toward the wall core of the workpiece from the outer circumferential surface and from the inner circumferential surface respectively and form a soft layer between said quench hardened layers,

said soft layer having a core region and intermediate regions, one of said intermediate regions being between said core region and a respective one of said quench hardened layers, said core region being composed of one or more structures selected from the group consisting of ferrite, pearlite, bainite and martensite which are precipitated during cooling from the quenching temperature and

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which contain or do not contain granular cementite dispersed therein.

Claim 31 (Original): A crawler belt bushing according to claim 30, wherein the hardened depth of the outer circumferential surface is not less than 1.1 times the hardened depth of the inner circumferential surface.

Claim 32 (Original): A crawler belt bushing according to claim 30, which is tempered at 140 to 350°C after quenching.

Claim 33 (Original): A crawler belt bushing according to claim 30, which is through hardened at its upper and lower ends.